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PROJECT NIGHT CAMERAS

Author Unknown

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PROJECT *NIGHT CAMERAS*

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ABSTRACT. The document consists of a two-part research proposal for extra-atmospheric astronomical observations to be conducted on rockets and satellites. Part I proposes the use of the Veronique-61 rocket to loft stable platforms carrying PUV and UVL cameras (field, 120° × 80°; aperture, $f/1$; objective diameter, 8 mm; recording method, Kodak 103 aO-UV and SC-5 film) to make a complete sky survey of stellar UV sources of magnitude $\leqslant$ 7.5 and weak diffuse light sources (nebulae, interplanetary gas, zodical light, gegenschein). Equipment and control systems specifications, launch and flight parameters, and operating procedures are described in detail. Part II proposes the use of larger cameras of the same type on orbital satellites to map the sky in the UV up to magnitude $\leqslant$ 10. The improved equipment proposed for satellite payload could also photograph the sky in the range 500-1000 Å and perform 3- or 4-color spectrophotometry and diffraction spectrography of stars of magnitude $\leqslant$ 5 with a divergence of 200 Å/mm. Data might be recovered by TV telemetry, but a recoverable photographic record is preferable. Preliminary equipment specifications, flight parameters, and operating procedures are given.

General Information /iii*

Title of Experimental Project: *Night Cameras*

(astronomical experiment by rocket and satellite)

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*Numbers in the margin indicate pagination in the foreign text.

Coordinating Engineer: Bernard Authier, Doctor of Engineering

I. Astronomical Experiment by Rocket /1

A. Scientific and Engineering Characteristics of the Experiment

(1) Description of the Experiment

This research proposal is based on results obtained with specially designed wide-field, high-luminosity cameras which were twice flown successfully on Veronique-61 rocket probes equipped with attitude control (Space General) and recovery systems.

The basic specifications of these cameras, which are described in detail in the attached document, are as follows:

approximate field . . . . 120° × 80°

relative aperture *f*/1

objective diameter . . . . 8 mm

recording method . . . . Kodak aO-UV or SC-5 film

limit magnitude attained during the launch of April 4, 1967 . . . . 7 - 7.5

(2) Scientific Objectives /2

The preliminary results obtained with these cameras are very briefly described in the attached document.

Cameras of this type can make a rapid preliminary survey of the sky in the ultraviolet; the detection during the launch of January 11, 1967 by one of these cameras of nebulae which are apparently related to those discovered by Kupperian and Bogges indicates that it would be of interest to devote several launches to the detection of the weak diffuse sources for which the instrument was designed.

Finally, these cameras offer the advantageous capability of carrying out two essential astronomical programs: (1) the detection of ultraviolet stellar radiation up to and beyond the seventh magnitude; and (2) the detection of weak diffuse sources (Milky Way isophotes, diffuse nebulae, interplanetary diffusion, zodiacal light, gegenschein, etc.).

The exposure time of 3 min used on previous launches shows no appreciable fogging due to sky background brightness, despite the detection of stars of a magnitude of 7.5 and of zodiacal light to within 53° of the sun. Both longer and considerably shorter exposures can be planned, though the majority of the /3
stars will be overexposed.

To our knowledge, there exist no other cameras with performance comparable to that of the proposed cameras, which makes their use to perform a complete survey of the celestial arc very desirable.

(3) Description and Operation of the Cameras

Figure 1 is a general view of the UVL camera, while Figures 2 and 3 show the UVL and PUV cameras mounted in the nose cone of the Veronique-61 launched in January 1967 at Hammaguir.

The operation of these two cameras is identical: the films are placed in film holders attached to two wires, which are wound on the drum of the feed magazine at launch.

The motor-driven drum of the takeup magazine pulls the film holders successively over the positioning frame located in the focal image plane (Figure 4). A switch system permits precise positioning of the film holders over the positioning frame.

The shutter is activated by an electromagnetic system. A complete operating cycle is described below, in the section on "Telemetry". The overall operation of each camera is controlled by a program device (see schematic diagram, Figure 5). /4

This program device is activated only by the command to begin the experiment, given by the nose cone central center.

(4) Dimensions and Weight

Overall dimensions of the PUV and UVL cameras are given in Plan No. 002, 050 c (for the PUV) and Plan No. 002,051 b (for the UVL), and the dimensions of the mountings in Plan No. 002,056 and Plan No. 002,057 a (for the UVL).

The dimensions of the program device are given in Plan No. 002,059. The center of gravity and weight of each item of equipment are also given in the above plans.

(5) Power Supply

The power supply for the entire assembly consists of a direct current of 27 V ± 10% and 3.8 A.

(6) Mounting

The cameras are to be mounted inside the nose cone behind hatches or panels which can be retracted to clear all parts of the camera field throughout the experiment. /5

It is desirable but not necessary for the fields of both cameras to be identical if two cameras are mounted on the same nose cone; nevertheless, it is quite possible to obtain interesting results with only one camera per nose cone.

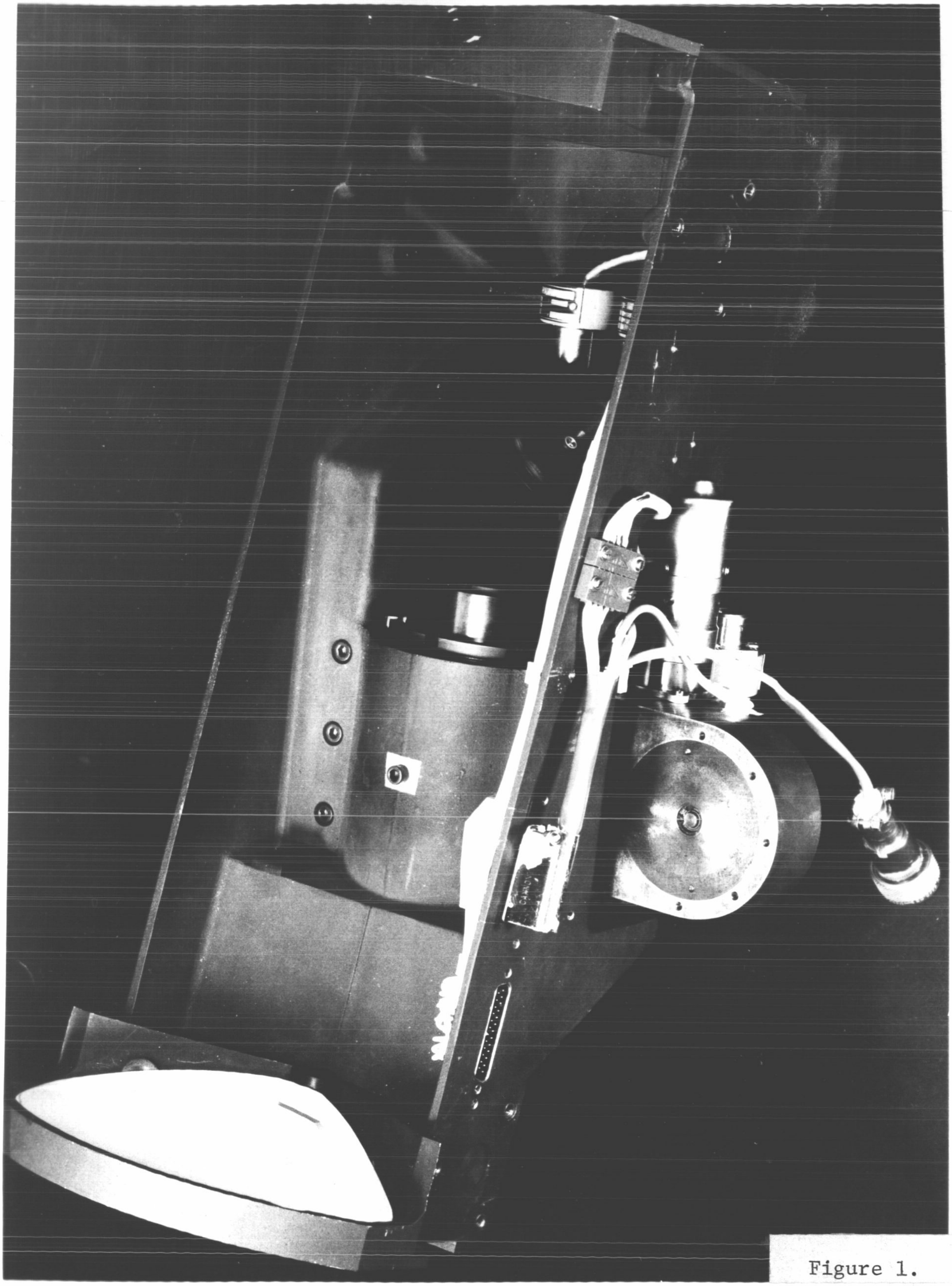


Figure 1.

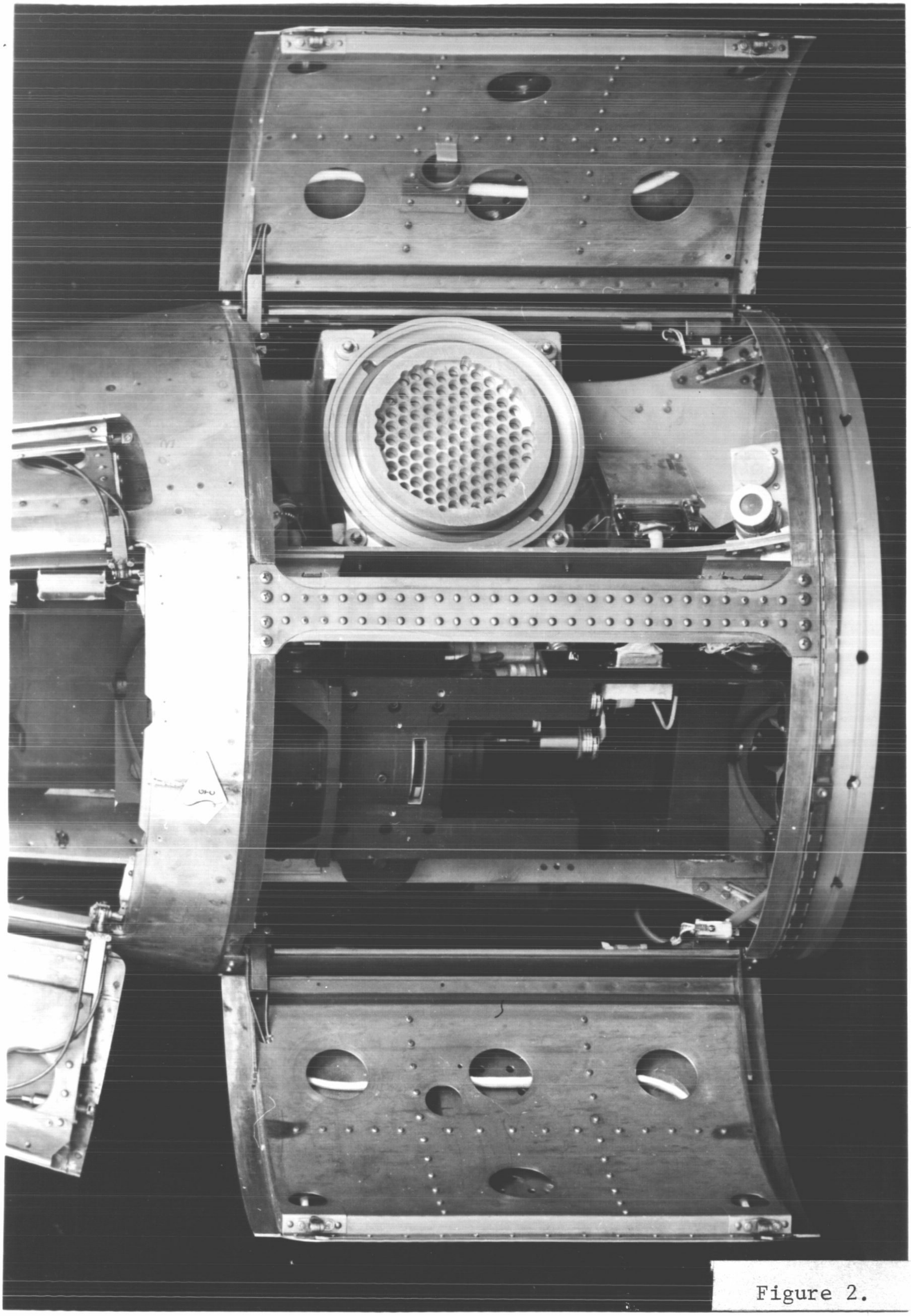


Figure 2.

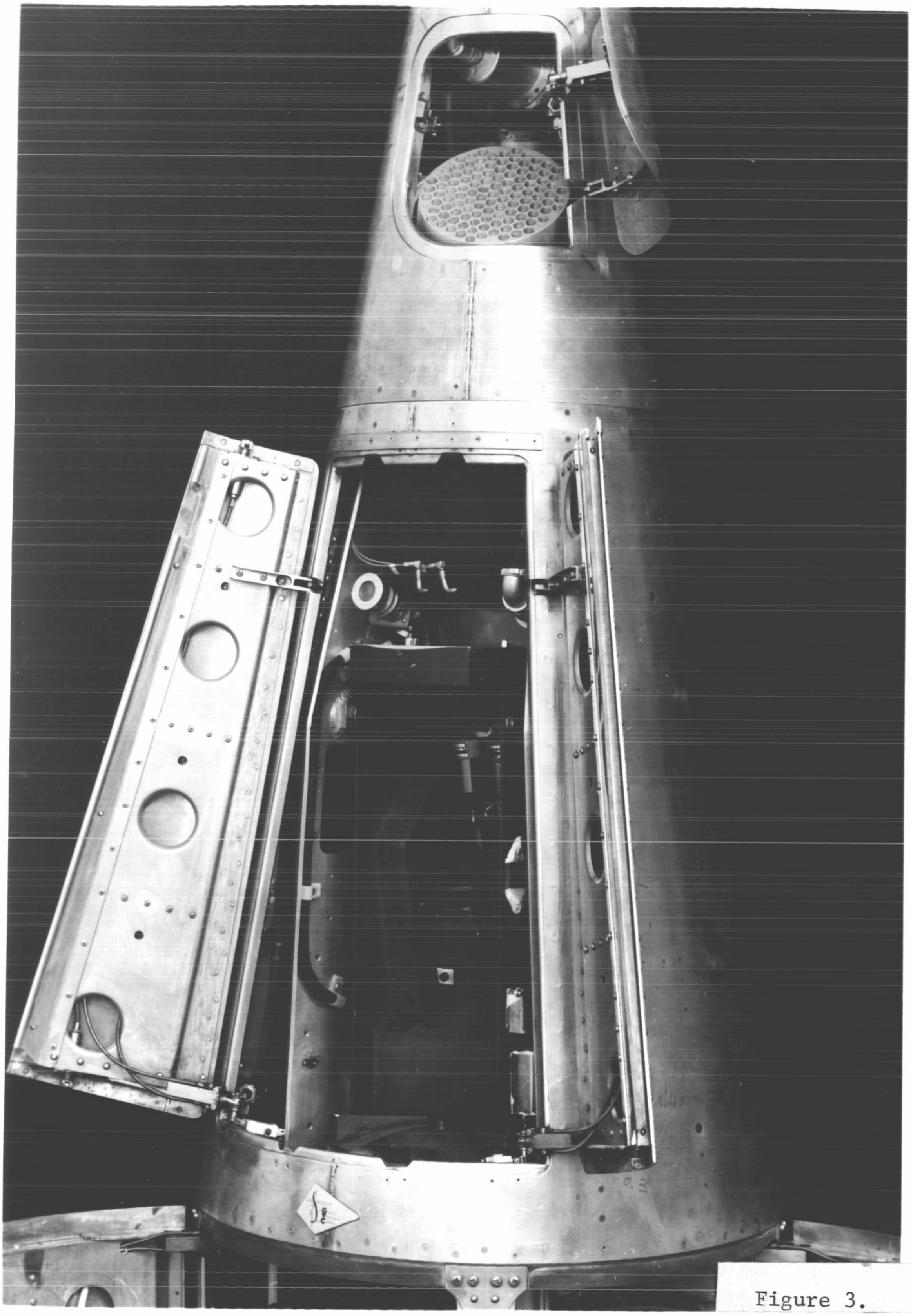


Figure 3.

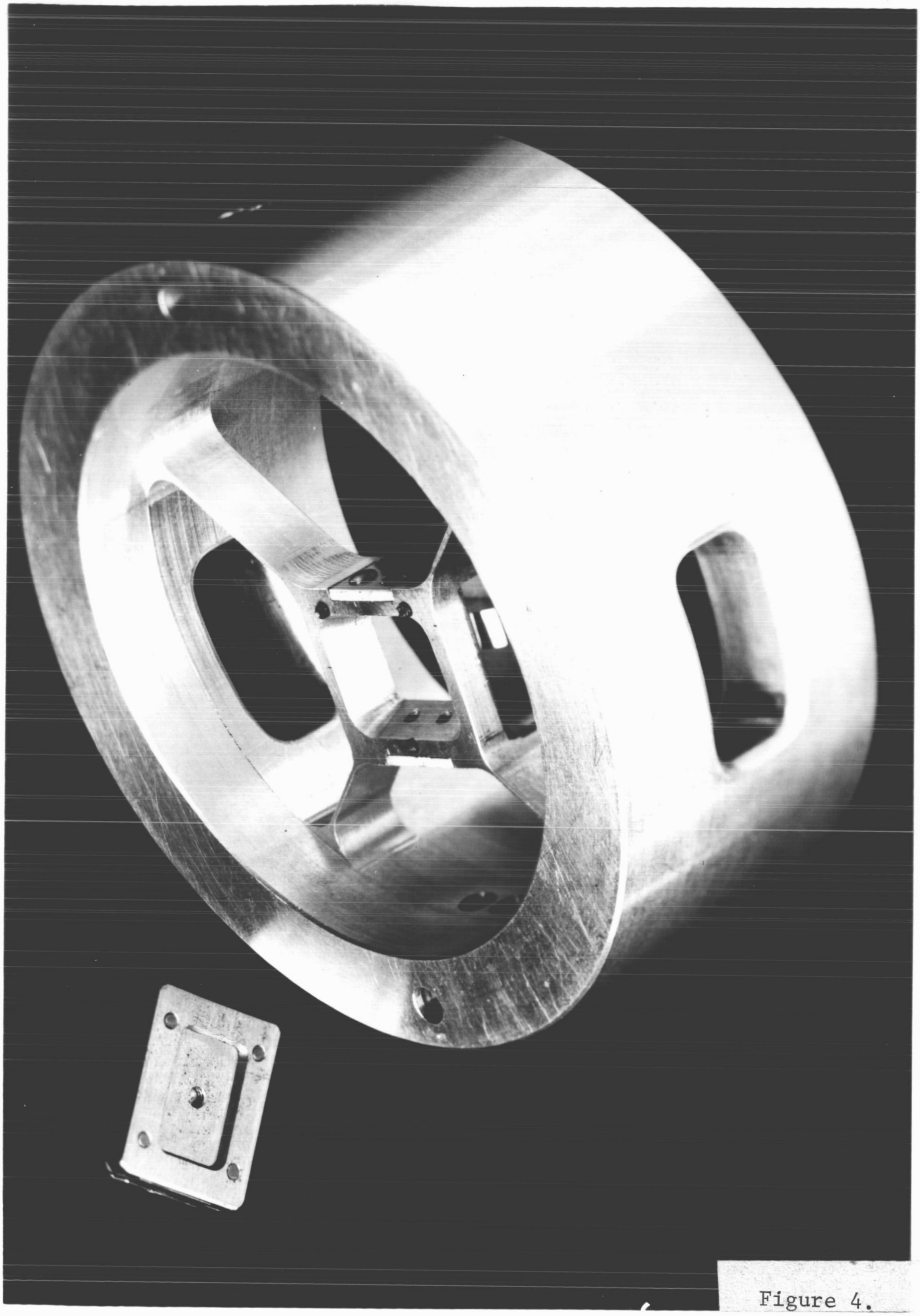
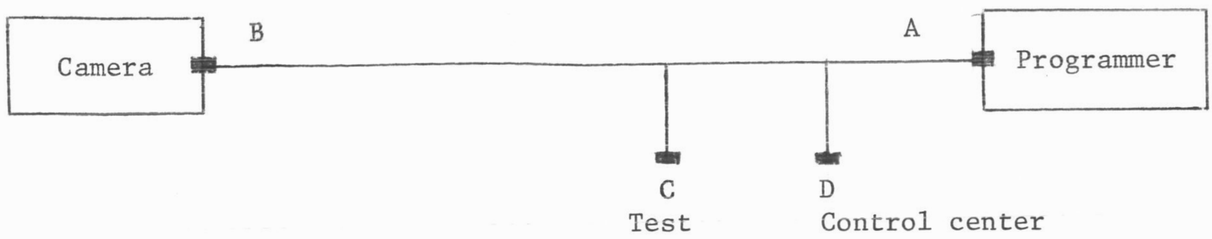


Figure 4.



Deutsch plugs;

A	DS04 19S DS07 19P
B	DS04 12P DS07 12S
C	DS04 7S DS07 7P
D	DS04 7S DS07 7P

Interface with the control center (plug D);

- power supply: 27 V; 3.8 A.
- telemetry
- telemetry output impedance 56 KΩ
- "closed contact" starting the program device
- "open contact" stopping the program device (optional)

Figure 5. Schematic Wiring Diagram of Night Camera.

(7) Planning

Some mechanical refinements suggested by previous launches are being incorporated into the cameras, which will be ready, together with the program device, in October 1967.

B. Launching and Flight Requirements

(1) Number of Launches

Several launches, with various trajectories designed to cover the entire sky would be desirable.

(2) Latitude of the Launch Pad

Not critical.

(3) Launch Windows

The experiment should be carried out at night, during the new moon. No standby launches are anticipated; precise launch windows will be calculated as soon as a decision has been reached on whether to make these experimental flights.

(4) Atmospheric Conditions on the Ground /6

Ground visibility is not critical. Preparation of the nose cone a few hours before the flight should be done in dry weather if it is desired to avoid damage to the coatings.

C. Rocket Vehicle Performance

(1) Trajectory

Altitude at apogee should be no less than 180 km; the experiment is possible above 100 km.

The experiment does not require the recording of any special information on the rocket trajectory.

(2) In-Flight Operations

The camera field must be clear throughout the flight.

(3) Recovery

Recovery of the take up magazines of each camera is indispensable to the success of the experiment. Recovery should be accomplished within 48 hours after launch; moreover, if the launch is made in a very hot climate, this time lapse should be shortened to prevent deterioration of the film. It should be /7 noted that the magazines are watertight.

(4) Attitude Control

An inertial triaxial attitude control system is required (maintaining a single camera pointing throughout the experimental portion of the flight).

These cameras were specially designed for compatibility with the performance characteristics of the attitude control system built by Space General (pointing precision ±2°, limit cycle ±10').

D. Equipment Required on Board

(1) Telemetry

Telemetry provides information on the performances of each camera and permits monitoring of the exposure time. It is thus necessary to provide a telemetry channel for each camera (though these may be multiplexed).

Analog signals are used (0, +2 V); required amplitude precision is 10%.

A typical flight sequence record is given in Figure 6. Output impedance is 56 KΩ.

(2) On-Board Recording

No on-board recording is required; however, camera performance may be re- /8
corded instead of telemetered.

(3) Control

No remote control is required. A present command (closed contact) causes the program device to start the experiment as soon as camera pointing is established, the camera fields are cleared, and an altitude of at least 100 km is reached.

E. Recording Requirements

(1) Trajectory

A recording accuracy of ±5 km on the altitude at any given time is sufficient. Examination of the negatives will establish the precision of camera pointing (approximately $0 \pm 2°$) and the limit cycle.

F. Interference

These cameras should not interfere with the equipment of possible co-experimenters and are themselves sensitive only to gas leaks or possible extraneous light sources which might exist on board the rocket.

Reflecting surfaces liable to throw parasite rays into the camera field /9
must also be avoided.

G. Operations on the Launch Pad

(1) Flight Preparation

The only ground installations required are a control room (about 15 m^2) and a darkroom for loading the cameras.

(2) Ground Communications

No concurrent ground experiments will be performed and no special communications are required.

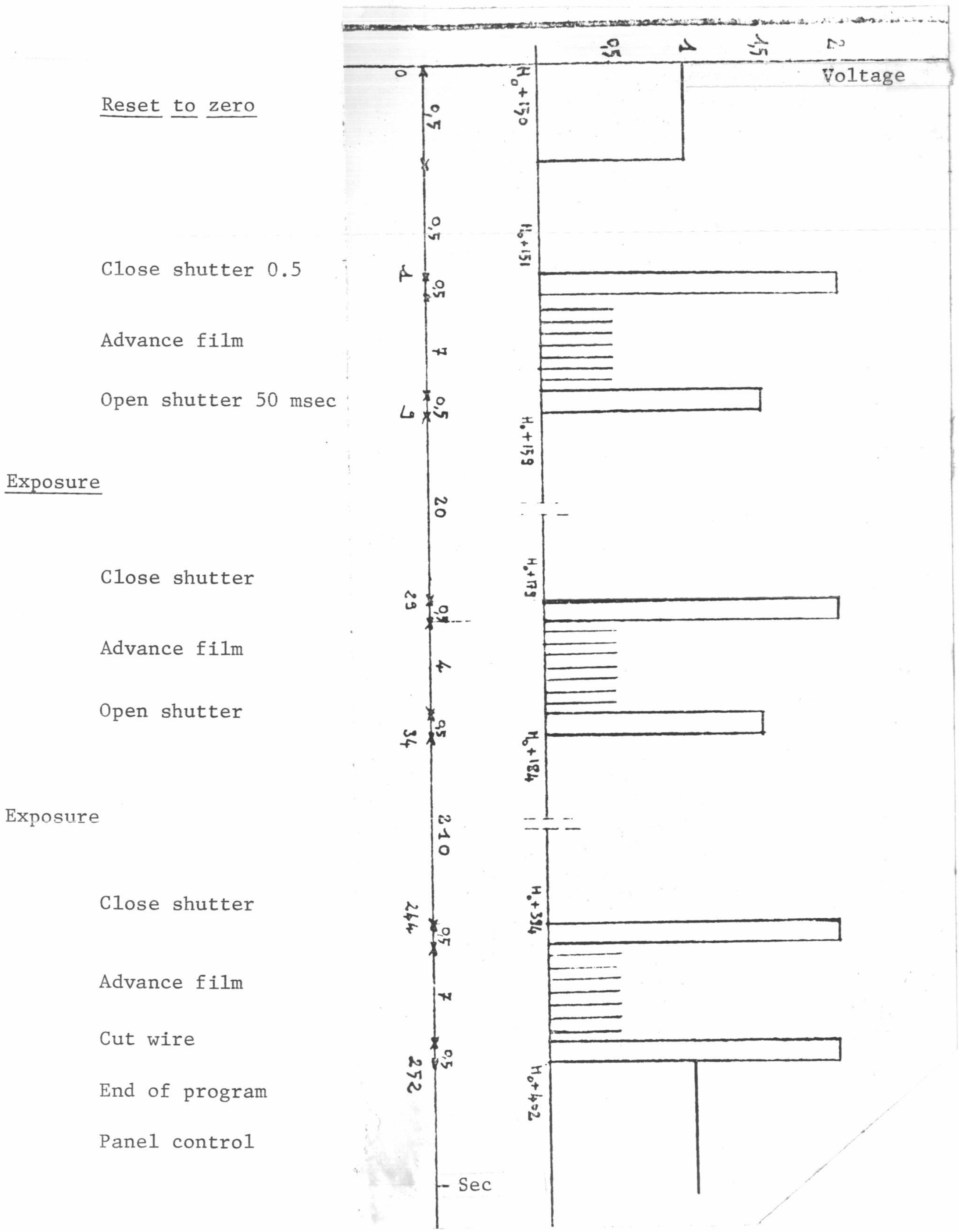


Figure 6. Flight Sequence Telemetry

(3) Inspection

A test plug is provided to verify proper camera functioning.

Preferably this test plug should be accessible through the open ports of the rocket; however, these tests can be made if necessary through the nose cone umbilicus plug.

To protect the optical system (from dust and coating damage by atmospheric agents), the mirrors are covered. The covers are removed as late as possible /10
(e.g., one hour before launch) when the preparation of the nose cone is finished.

II. Astronomical Experiment by Satellite /11

A. Scientific and Engineering Characteristics of the Experiment

(1) Description of the Experiment

Based on the results described above, it is easy to write specifications for a considerably more sensitive camera.

Exposure times may be the same or even longer, since the sky background brightness did not register with the three minute exposures used in the preceding experiments, indicating that exposures at least three times as long can be used.

Such a camera would be capable of mapping the sky rapidly and completely in the ultraviolet up to the tenth magnitude.

The recording method used would still be photographic film recovered in a detachable magazine with maximum dimensions of 10 × 10 × 5 cm.

The dimensions of the instrument would be 150 × 40 × 40 cm, although the instrument can be designed in a variety of sizes ranging from the present size /12
(60 cm in length) to 200 cm.

Depending on the vehicle chosen, the field could embrace a complete revolution around the axis of aim or could be limited to one sector like the field of the cameras described in Part I above, for which the path of the field on the celestial globe is shown in Figure 7.

The research proposal is not limited to broad passband photography of the sky unless the engineering characteristics of the vehicle impose this limitation.

Without great difficulty, the experimenter can use the same instrument to obtain general photographs of the sky (passbands from 500 to 1000 Å), as well as perform spectrophotometry in three or four colors and diffraction grating spectrography of stars up to the fifth magnitude with a divergence of 200 Å/mm.

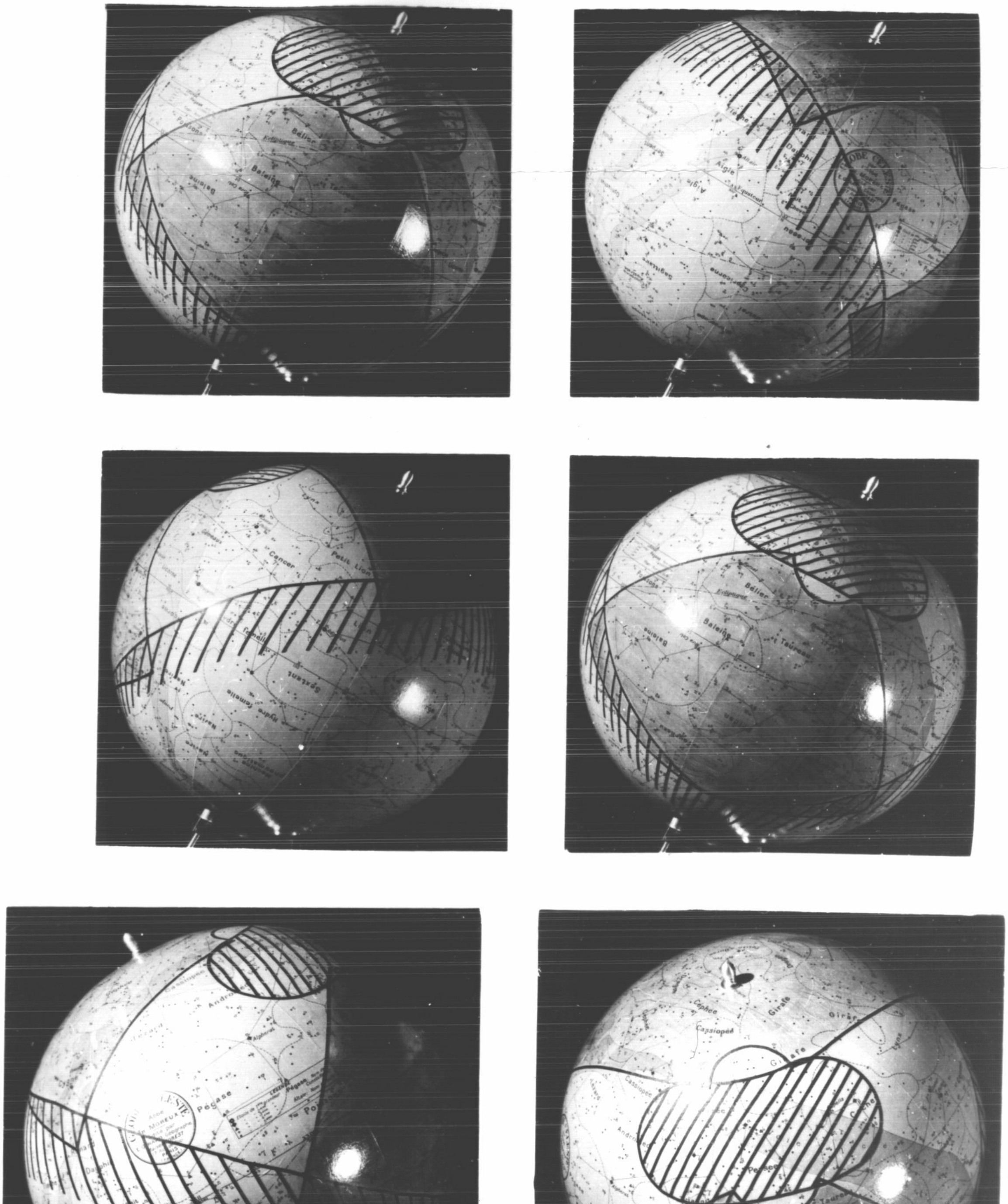


Figure 7.

These data would be obtained simultaneously and stored in the same ejectable magazine as the film.

We prefer the photographic method because of its simplicity and excellent results. If film recovery is not feasible, a television system could be considered. However, television scanning, which sweeps a field of 50° at intervals of 1' of arc, would certainly not permit the same sensitivity to be achieved with equivalent experiment durations. /13

(2) Scientific Objectives

Using this type of camera, a complete sky chart can be made with a dozen camera pointings, since each field includes about $50°^2$.

(3) Description and Operation of the Cameras

The operative principle of these cameras is identical with that of the cameras described above, except that the film holders are replaced by roll film arranged to permit making thirty negatives in succession.

The exposures could be made on receipt of an aim signal. Camera pointing could be accomplished either by vehicle systems or by an aiming device built into the camera.

(4) Dimensions and Weight

The overall dimensions of this type of camera can vary between those given for the cameras in Part I, above, to a size of 200 × 50 × 50 cm; the weight would range from 12 to 45 kg. /14

Either one or two cameras might be mounted in the vehicle, depending on availability of space.

(5) Power Supply

A direct current power supply of 27 V ±10% and 1 A is provided; total power consumption should be of the order of 0.10 Ah.

(6) Attitude Control

It will be necessary to make a dozen camera pointings, one or several times, with a precision of the order of 3° and a limit cycle of less than 1' or equivalent.

These pointings should be made at night, with the sun at -20°, and during the new moon.

(7) Mounting

The cameras must be mounted so that the temperature of the film magazines can be maintained between -20°C and +40°C. /15

A study will be made to determine the effect of direct sunlight falling on the collecting mirrors. This study may lead to the installation of a panel to protect the optical system from direct sunlight. This protective panel could be activated by solar cells.

(8) Planning

If the photographic recording method and camera pointing by vehicular systems are to be used, preparation of the experiment will take a year and a half from the time when the final proposal is finished.

If camera pointing is to be accomplished by the experimenter, preparation time can be reduced to one year.

If a television camera tube is to be used, a preparation time of three to four years must be anticipated.

B. Telemetry and Remote Control

The only telemetry required is that necessary to monitor exposure times (film advance) and shutter function.

Remote control is not required, unless considerations of simplicity make /16
it advantageous to trigger the exposures from the ground on receipt of a telemetered aim signal.

C. Orbit

(1) Apogee and Perigee

The only limitation is that the apogee must be such as to avoid bombardment by extra-atmospheric particles damaging the film.

(2) Orbit

Not critical. The camera pointings can be accomplished during one or several orbits. Two negatives will be taken at each pointing, a short exposure of 10 to 20 sec and a long exposure of at least three minutes.

D. Recovery

Recovery of the film is imperative. The magazine might be designed for /17
recovery by an astronaut.

E. Information Requirements

(1) Orbital Data

A precision of a few kilometers on the position of the satellite at any given time is sufficient.

(2) Attitude

The precision of camera pointing can be established by examining the negatives.

F. Interference

The experiment is sensitive only to gas or smoke leaks which might fog the film or damage the optical system, and to parasite reflections or extraneous light sources which also might fog the film.

It seems perfectly feasible to conduct any other sort of experiment on the same vehicle. /18

G. Concurrent Measurements

No concurrent on-board measurements are required and no concurrent ground measurements are planned.

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